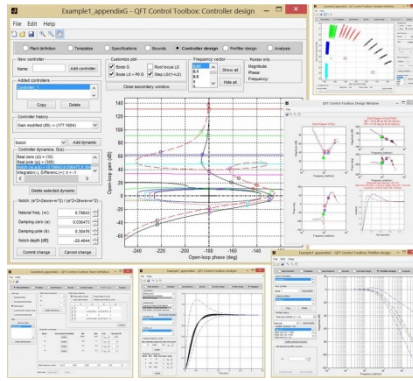
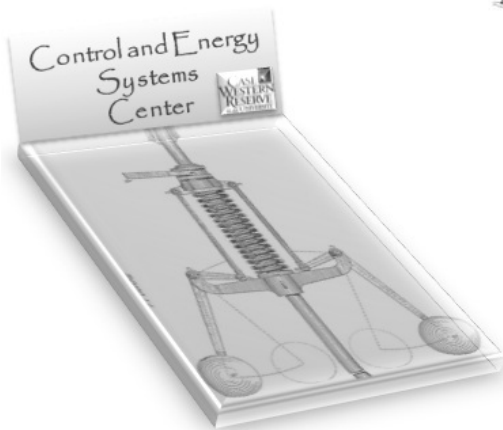


**Wind Energy Systems: Control Engineering Design**

Mario Garcia-Sanz and C.H. Houpias  
 CRC Press, Taylor & Francis, USA.  
 ISBN: 978-1-4398-2179-4, February 2012.

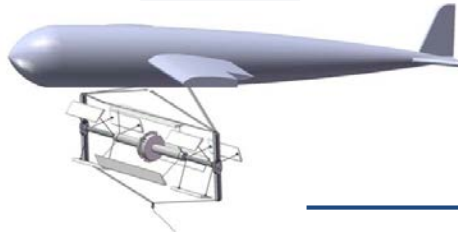
**An Innovative Approach to Airborne Wind Energy: The EAGLE System.**

Designed and patented at CESC. 2.5 kW, 25 kW or 100 kW aloft wind turbine at varying altitudes.



The QFT Control Toolbox (QFTCT) for MATLAB is the interactive and user-friendly tool for QFT robust control systems design (Quantitative Feedback Theory) developed by Prof. Mario Garcia-Sanz.

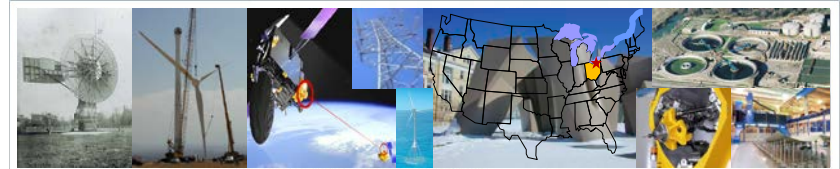
Over the years, the toolbox has been widely applied by industry, space agencies, research centers and universities to design QFT robust control solutions and servo-systems.



**Acknowledgements**

The *Control and Energy Systems Center* was established at Case Western Reserve University with the support of the Milton and Tamar Maltz Family Foundation and the Cleveland Foundation.

*The Milton and Tamar Maltz Professorship in Energy Innovation*



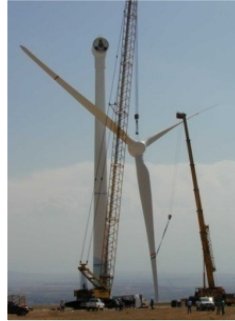
Over 25 years designing Control Systems and Wind Turbines for Industry leaders!!!



Prof. **Mario Garcia-Sanz**, Dr.Eng.  
 Milton and Tamar Maltz Professor in Energy Innovation  
 Director, *Control and Energy Systems Center*  
 Case Western Reserve University  
 10900 Euclid Ave., Cleveland, Ohio 44106-7071  
 Email: mario@case.edu , Web: http://cesc.case.edu

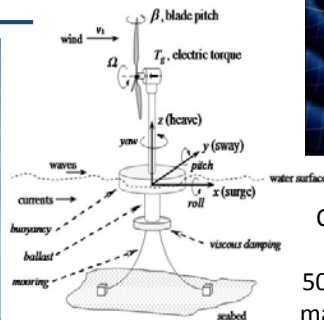
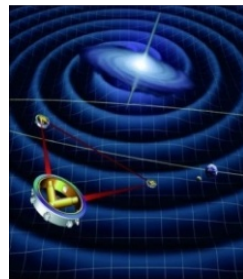
## Mission

The *Control and Energy Systems Center (CESC)* looks for new transformational research and engineering breakthroughs to build a better world, improving our industry, economy, energy, environment, water resources and society, all with sustainability and within an international collaboration framework.

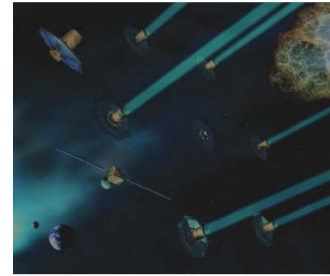


## Focus

With an interdisciplinary and concurrent engineering approach, the *Control and Energy Systems Center* focuses on bridging the gap between fundamental and applied research in advanced control and systems engineering, with special emphasis in energy innovation, wind energy, power systems, water treatment plants, sustainability, spacecraft, environmental and industrial applications.



Over 20 patents, 200 research papers and 50 large projects with major industry leaders and space agencies



$$\frac{g_{ii}^i}{1+J_i^i} \leq \left\{ \left( \sum_{x=1}^{i-1} a_{ix} \beta_{ij} \right) + \beta_{ij} - \sum_{k=i+1}^n (p_{ik}^i + g_{ik}^i) \tau_{kj} \right\}_{y, \max}$$

$$a_{ix} = \begin{cases} 1 & (\text{if } i=x) \\ 0 & (\text{if } i < x) \\ \sum_{\substack{\text{from } m-1 \\ \text{to } m-i-x}}^{i-x-1} \text{elements} \prod_{\substack{m \text{ elements} \\ (p_{bb}^{*b} + g_{bb}^{*b})}} \frac{-(p_{ab}^{*b} + g_{ab}^{*b})}{(p_{bb}^{*b} + g_{bb}^{*b})} & (\text{if } i > x) \end{cases}$$



## Fundamental Research

To gain knowledge and understanding on multi-input-multi-output physical worlds, nonlinear plants, distributed parameter systems, plants with non-minimum phase, time delay and/or uncertainty, etc., and to develop new methodologies to design quantitative robust controllers to improve the efficiency and reliability of such systems.

## Applied Research

To develop advanced solutions with industrial partners, for practical control engineering problems in Energy Systems, Multi-megawatt Wind Turbines, Renewable Energy Plants, Power System Dynamics and Control, Grid Integration, Energy Storage, Power Electronics, Wastewater Treatment Plants, Desalination Systems, Formation Flying Spacecraft, Satellites with Flexible Appendages, Heating Systems, Robotics, Parallel Kinematics, Telescope Control, etc.

The **Control and Energy Systems Center (CESC)** is an interdisciplinary and international team of professors and researchers. See <http://cesc.case.edu> EECS & EMAE departments, Case School of Engineering.